Building Java Programs

Chapter 10

Lecture 10-1: `ArrayList`

reading: 10.1

Welcome to CSE 143!

I'm Hélène Martin

http://cs.washington.edu/143

CSE 143

- Goal: learn tools for automating complex tasks efficiently
  - Abstraction (client vs. implementation)
  - Data structures
  - Algorithms
- Prerequisite: can automate basic tasks using a programming language (logic, control flow, decomposition)
- For EVERYONE, not just CSE majors
- Learn by doing
- Lots of support (undergraduate TAs, IPL, message board)

Programming

- CS: "efficiently implementing automated abstractions" [1]
- Building things is empowering
  - Small number of fundamentals can solve lots of problems
  - When a program works, it's obvious
  - Welding, chain saws, safety glasses not required
- A LOT of complexity to master: exciting and scary
- Java is our tool in 14x but lessons transfer broadly

1 http://www.pgbovine.net/what-is-computer-science.htm

Being Successful

- Determination, hard work, focus
- Investing time (~15 hours a week)
  - Starting early
  - Developing problem-solving strategies
  - Developing a consistent style
- Knowing when to ask for help
  - Go to the IPL
  - Talk to me after class, during office hours
- Studying together
  - Homework is individual but studying in groups pays off

Logistics

- Get to know http://cs.washington.edu/143
- 2 sections a week
  - Turn in ONE set of problems each week for credit
- Grading described on syllabus
  - 45% projects, 20% midterm, 35% final
- Weekly programming projects
  - Academic honesty is serious
  - 40 point scale
  - 5 "free late days"; -2 for subsequent days late

Words exercise

- Write code to read a file and display its words in reverse order.

- A solution that uses an array:

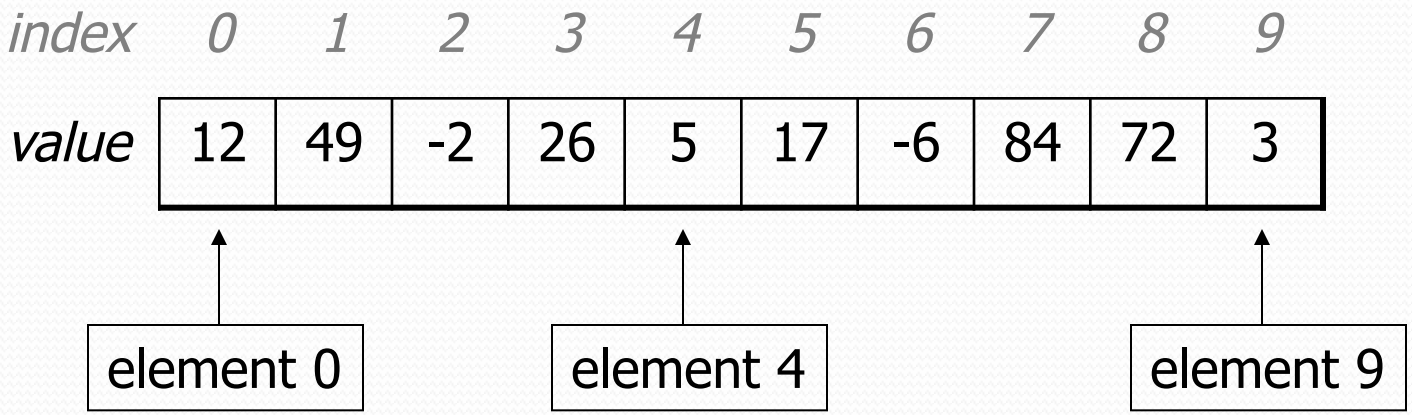
```
String[] allWords = new String[1000];
int wordCount = 0;

Scanner input = new Scanner(new File("words.txt"));
while (input.hasNext()) {
    String word = input.next();
    allWords[wordCount] = word;
    wordCount++;
}
```

- What's wrong with this?

Recall: Arrays (7.1)

- **array**: object that stores many values of the same type.
  - **element**: One value in an array.
  - **index**: 0-based integer to access an element from an array.
  - **length**: Number of elements in the array.



length = 10

Array Limitations

- Fixed-size
- Adding or removing from middle is hard
- Not much built-in functionality (need Arrays class)

List Abstraction

- Like an array that resizes to fit its contents.
- When a list is created, it is initially empty.

```
[]
```

- Use `add` methods to add to different locations in list

```
[hello, ABC, goodbye, okay]
```

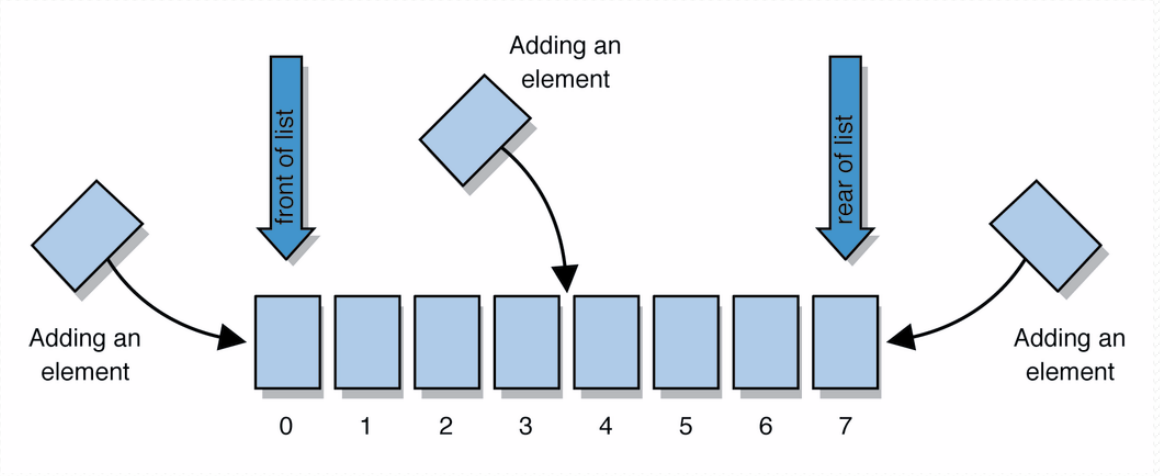
  - The list object keeps track of the element values that have been added to it, their order, indexes, and its total size.
  - You can add, remove, get, set, ... any index at any time.

Collections and lists

- **collection**: an object that stores data ("**elements**")

```
import java.util.*;   // to use Java's collections
```

- **list**: a collection of elements with 0-based **indexes**
  - elements can be added to the front, back, or elsewhere
  - a list has a **size** (number of elements that have been added)
  - in Java, a list can be represented as an **`ArrayList`** object



Type parameters (generics)

```
ArrayList<Type> name = new ArrayList<Type>();
```

- When constructing an `ArrayList`, you must specify the type of its elements in `< >`
  - This is called a *type parameter* ; `ArrayList` is a *generic* class.
  - Allows the `ArrayList` class to store lists of different types.
  - Arrays use a similar idea with **Type**`[]`

```
ArrayList<String> names = new ArrayList<String>();
names.add("Marty Stepp");
names.add("Stuart Reges");
```

`ArrayList` methods (10.1)*

`add(`**value**`)`	appends value at end of list
`add(`**index**`, `**value**`)`	inserts given value just before the given index, shifting subsequent values to the right
`clear()`	removes all elements of the list
`indexOf(`**value**`)`	returns first index where given value is found in list (-1 if not found)
`get(`**index**`)`	returns the value at given index
`remove(`**index**`)`	removes/returns value at given index, shifting subsequent values to the left
`set(`**index**`, `**value**`)`	replaces value at given index with given value
`size()`	returns the number of elements in list
`toString()`	returns a string representation of the list such as `"[3, 42, -7, 15]"`

* *(a partial list; see 10.1 for other methods)*

ArrayList vs. array

```
String[] names = new String[5];              // construct
names[0] = "Jessica";                        // store
String s = names[0];                         // retrieve
for (int i = 0; i < names.length; i++) {
    if (names[i].startsWith("B")) { ... }
}                                            // iterate
```

```
ArrayList<String> list = new ArrayList<String>();
list.add("Jessica");                         // store
String s = list.get(0);                      // retrieve
for (int i = 0; i < list.size(); i++) {
    if (list.get(i).startsWith("B")) { ... }
}                                            // iterate
```

ArrayList as param/return

```
public static void name(ArrayList<Type> name) {// param
public static ArrayList<Type> name(params)    // return
```

- Example:

```
// Returns count of plural words in the given list.
public static int countPlural(ArrayList<String> list) {
    int count = 0;
    for (int i = 0; i < list.size(); i++) {
        String str = list.get(i);
        if (str.endsWith("s")) {
            count++;
        }
    }
    return count;
}
```

Words exercise, revisited

- Write a program that reads a file and displays the words of that file as a list.
  - Then display the words in reverse order.
  - Then display them with all plurals (ending in "s") capitalized.
  - Then display them with all plural words removed.

Exercise solution (partial)

```
ArrayList<String> allWords = new ArrayList<String>();
Scanner input = new Scanner(new File("words.txt"));
while (input.hasNext()) {
    String word = input.next();
    allWords.add(word);
}

// display in reverse order
for (int i = allWords.size() - 1; i >= 0; i--) {
    System.out.println(allWords.get(i));
}

// remove all plural words
for (int i = 0; i < allWords.size(); i++) {
    String word = allWords.get(i);
    if (word.endsWith("s")) {
        allWords.remove(i);
        i--;
    }
}
```